

DRAFT BMP test 2 report 1 for lab R06

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07 October, 2024 - 10:13

1. Report summary

This report summarizes BMP results from a single laboratory from the second BMP test in the IL-BMP-2023-2024 project. For questions, to discuss any problems with the test, or to ask for advice on BMP measurement and data processing, contact me at sasha.hafner@bce.au.dk. The report includes our assignment of your laboratory into one of the following groups:

- “A” laboratories submitted reasonably accurate results in BMP test 2.
- “B” laboratories had problems in one or more areas.

Based on our evaluation of your results, your laboratory is in the following group:

A.

Laboratories that were in group A for either test 1 or test 2 are considered “certified” by this IL-BMP-2023-2024 project. If your laboratory was already certified based on test 1 results, assignment into group B in test 2 will not change that original assessment. Additionally, all of these reports have been manually evaluated, and in a small number of cases a laboratory was certified despite assignment into group B, for example when a cutoff was exceeded in a single case by a small quantity or where a single unusual outlier (one bottle) could be identified.

Considering all this, your laboratory is:

A reference lab, and so not evaluated like the other labs. Other labs (regular participants) will see “certified” or “not certified” here.

If your laboratory was not certified in this study, please check the problems highlighted in this report and the report for test 1 (please contact me if you do not have a copy). You can send me a message (sasha.hafner@bce.au.dk) with questions or to set up a meeting to discuss troubleshooting if you are interested in improving your BMP measurement accuracy.

And even if your laboratory was certified, still please take a look at the results below and consider how any problems can be addressed.

Details on the evaluation can be found in the remainder of the report. Please take a careful look. If your laboratory is in group B, please check your submitted data and calculations for errors. If you find any errors, please correct and resubmit your test 2 results. If we found problems with your calculations, you should check your template or script or simply replace it with [OBA](#). If it was your TS or VS results that were problematic, and you cannot find unit or calculation errors (a few labs have already corrected VS results that were mistakenly submitted in % of fresh mass (FM) instead of % of TS), then try to identify and address problems with your TS/VS measurements and repeat. You can find more detailed instructions in the sections below. Once you submit corrected (or, for TS/VS, new) data, it is possible to move from group B to group A (this has already happened for some laboratories).

Below, find a summary of our evaluation of your BMP results. See the relevant report section for details.

Criterion	Description	Result
1	Reported BMP within 15%/25%	OK
2	Calculated BMP within 15%/25%	OK
3	Duration meets 1% net 3 d	OK
4	Relative standard deviation < 10%	OK
5	Calculation difference < 10%	OK
6	TS within 5%	OK
7	VS within 2%	OK

2. BMP results (criteria 1 and 2)

Here, your BMP values are compared to median values from the reference labs. *All BMP values below are in mL of methane (standardized to 1.0 atm (101.325 kPa), 0 °C, and dry conditions) per g of substrate VS.* Problems are flagged if your BMP values are more than 15% away from the median of the reference labs, with the exception of a single substrate (which must be within 25% of the reference value).

The first comparison is based on your reported BMP values. So differences could be due to many different problems, including gas volume measurement error, inactive inoculum, or data processing errors, for example. The theoretical maximum BMP (based on elemental composition) is included for comparison. Are there problems with your results?

No.

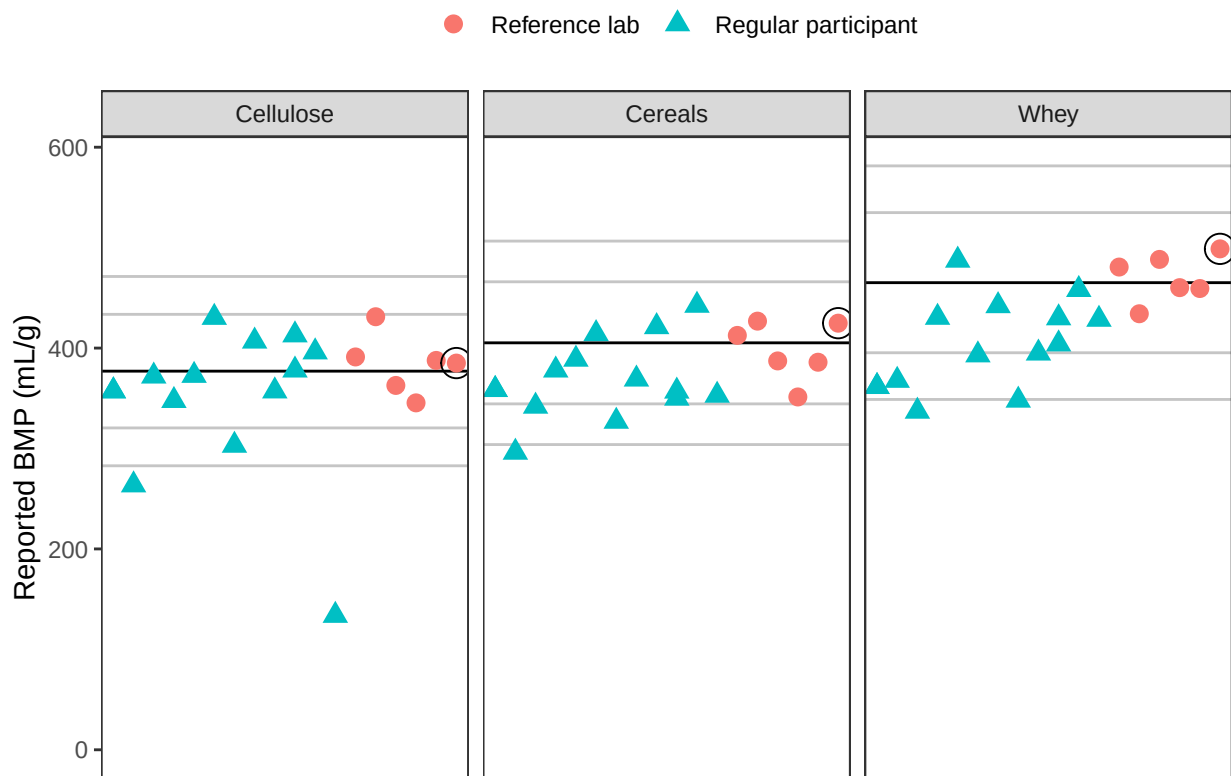
Substrate	Theoretical max. BMP	Reference BMP	Your reported BMP	Difference (%)
Cellulose	414	377	385	2.1
Cereals	447	405	425	4.8
Whey	526	465	499	7.2

The second comparison is based on BMP values that we calculated from your raw data using VS measurements from the reference labs in order to isolate measurement errors (this is called “Your BMP calculated by us” in the table below). If there was a calculation error in your reported BMP results, this comparison might be more favorable than one based on your reported BMP values. However, if there was an error in entry of raw data or interpretation of raw data that could inflate the error seen in the table below. Are there any problems?

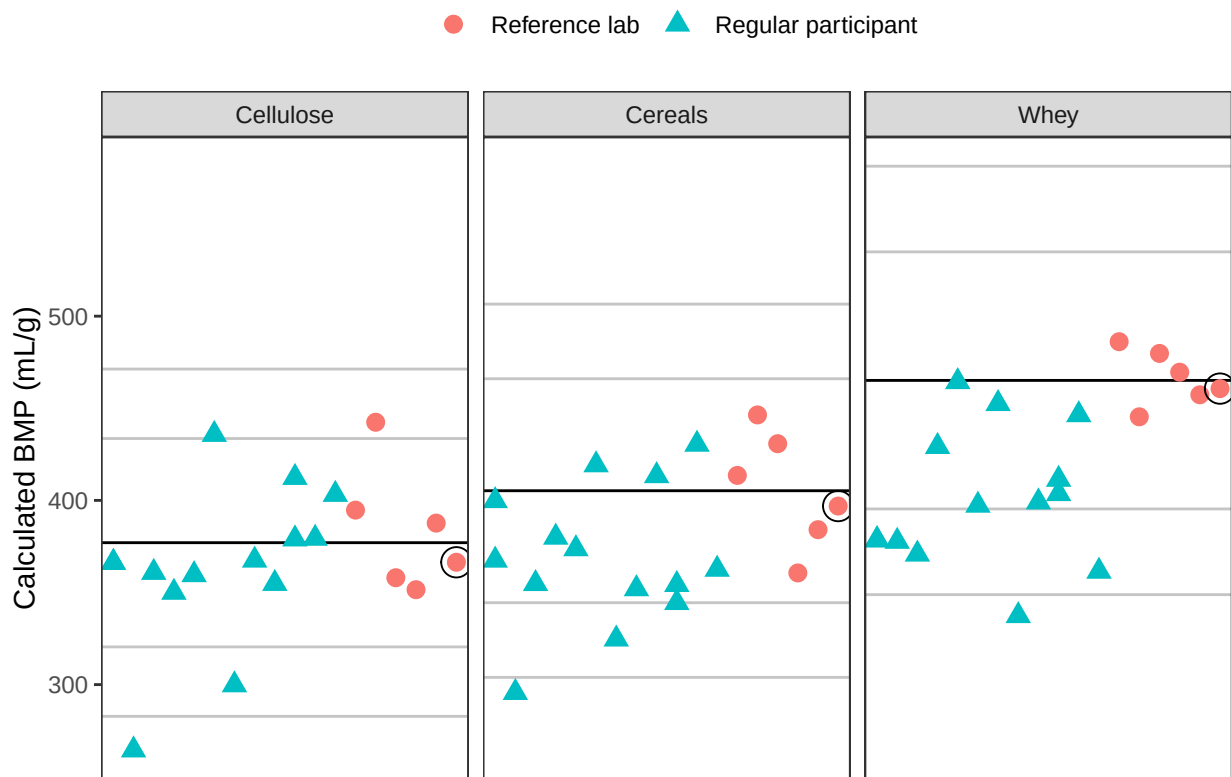
No.

Substrate	Theoretical max. BMP	Reference BMP	Your BMP calculated by us	Difference (%)
Cellulose	414	377	366	-2.8
Cereals	447	405	397	-2.1
Whey	526	465	461	-1.0

You can see how your BMP values (circled) compare to other labs in the plots below. The black horizontal line shows reference values, taken as the median of reference laboratory results. The cutoff values are shown as light gray horizontal lines. First reported BMP values.



And then the values we calculated from submitted raw data. Note that the y axis scales may vary.

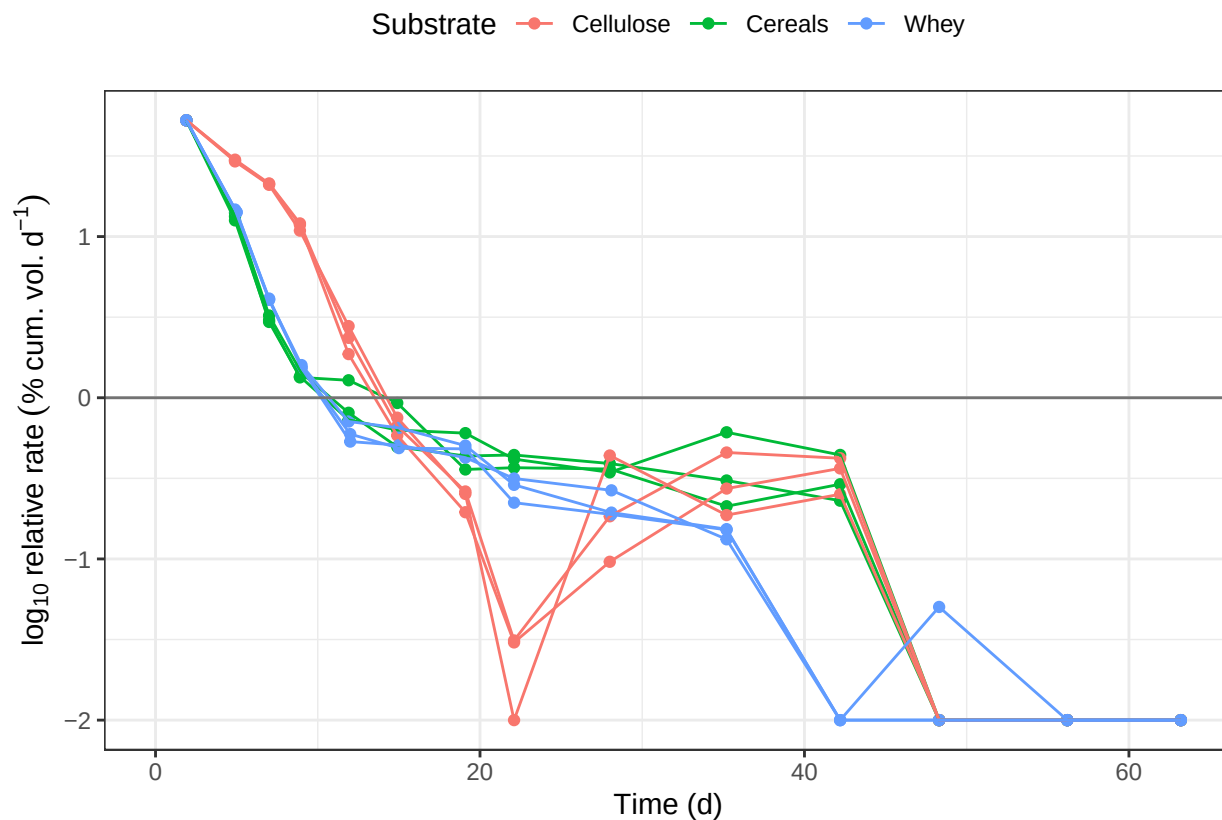


3. Rate criterion (criterion 3)

Did you run each substrate to the 1% net 3 d criterion?

Yes.

Substrate	Test duration (d)	1% net 3 d time
Cellulose	63	15
Cereals	63	15
Whey	63	15



If you thought you did run to this criterion but did not, consider using OBA to check next time. The requested criterion is 1% net for 3 days (in OBA it is called “1% net cum./d, 3 d”).

4. Relative standard deviation (criterion 4)

Here the cutoff is 10%. Are there any problems?

No.

Substrate	Relative standard deviation (%)
Cellulose	1.5
Cereals	2.2
Whey	2.9

5. Data processing calculations (criterion 5)

Here your reported BMP values are compared to the values we calculated from the raw data that you submitted. Differences indicate one of three possibilities:

1. Differences in data processing calculations
2. Errors in entry of raw data or your BMP values
3. Misinterpretation of raw data

If there are differences (with a cutoff of 10%), it is important to identify and address the cause. Check your entered data for mistakes, which could be present in either the raw data or the BMP values you calculated. Remember that BMP should be expressed as standardized methane (not biogas) volume. The convention in the biogas world that we are using here is to standardize to 1.0 atm (101.325 kPa), 0 °C, and dry conditions. If you need to correct submitted data, please do so using the edited version of the spreadsheet file that was sent to you earlier. This is important because we had to edit several submitted files to correct data entry mistakes. If you don't have it, please ask for a copy by email.

If you do not see any data entry errors, but cannot match the results we calculated from your raw data, the problem is likely in your data processing templates or scripts. In that case you should revise your templates or scripts and ensure that you can match the results we get. For guidance on data processing, see the detailed 200 series documents on the [Standard BMP Methods website](#). These are the methods agreed upon by some 30 or 40 biogas researchers, and are those that we used for data processing, through the [biogas package](#). Alternatively, and perhaps preferably, you can simply use available standardized software to carry out data processing. Anyone with a web browser can use OBA, which is available for free here: <https://biotransformers.shinyapps.io/oba1/>, with detailed instructional videos here: <https://www.youtube.com/playlist?list=PLt5lRUaaL8JMKDyuRIrKkuloRQk6YmYhn>. And as long as you fill in the substrate VS mass column in the "Setup" sheet, you can use your completed IL-BMP-2023-2024 spreadsheet template directly in OBA. Note that OBA works for multiple methods and data structures. Those who already work in R can use the biogas package, which is available on CRAN. (The biogas package is what we used to calculate BMP from your raw data.)

Are there large differences between your reported BMP values and those we calculated from your raw data (using your VS measurements)? The cutoff is 10%.

No.

Substrate	Reported BMP	Calculated BMP	Calc. diff. (%)
Cellulose	385	365	5
Cereals	425	399	7
Whey	499	466	7

6. Total solids and volatile solids (criteria 6 and 7)

Here your reported total solids (TS) and volatile solids (VS) results are compared to reference values. In case of problems, first check the units. We are using TS as a percentage of fresh mass (FM), and VS as a percentage of TS. If it isn't a problem with units, check your method. TS should be measured by drying at 105 °C, and VS by calcination at 550 °C. You can find links to free documents on TS and VS measurement in [Document 100](#). Low VS results suggest that calcination was incomplete. Low TS results could be the results of sample contamination or wet crucibles. High TS results may be caused by not drying for long enough. Alternatively, calculation errors could explain any deviation.

Your results:

Substrate	TS (% FM)	VS (% TS)
Cellulose	99.4	100.0

Substrate	TS (% FM)	VS (% TS)
Cereals	88.8	97.8
Whey	93.7	96.5

Any TS problems (cutoff is 5% of FM)?

No.

Any VS problems (cutoff is 2% of TS)?

No.

7. Test setup and inoculum-to-substrate ratio

Test setup data are shown below, both for checking for labeling or input errors and to check inoculum-to-substrate ratio (ISR). These data were not directly used in the evaluation. An ISR of 2:1 (VS basis) was requested in the protocol but deviation from this was accepted (we are not asking labs to run BMP test 2 just because of an ISR value different from 2:1). However, if we found problems with your BMP results you should check the ISR that you used.

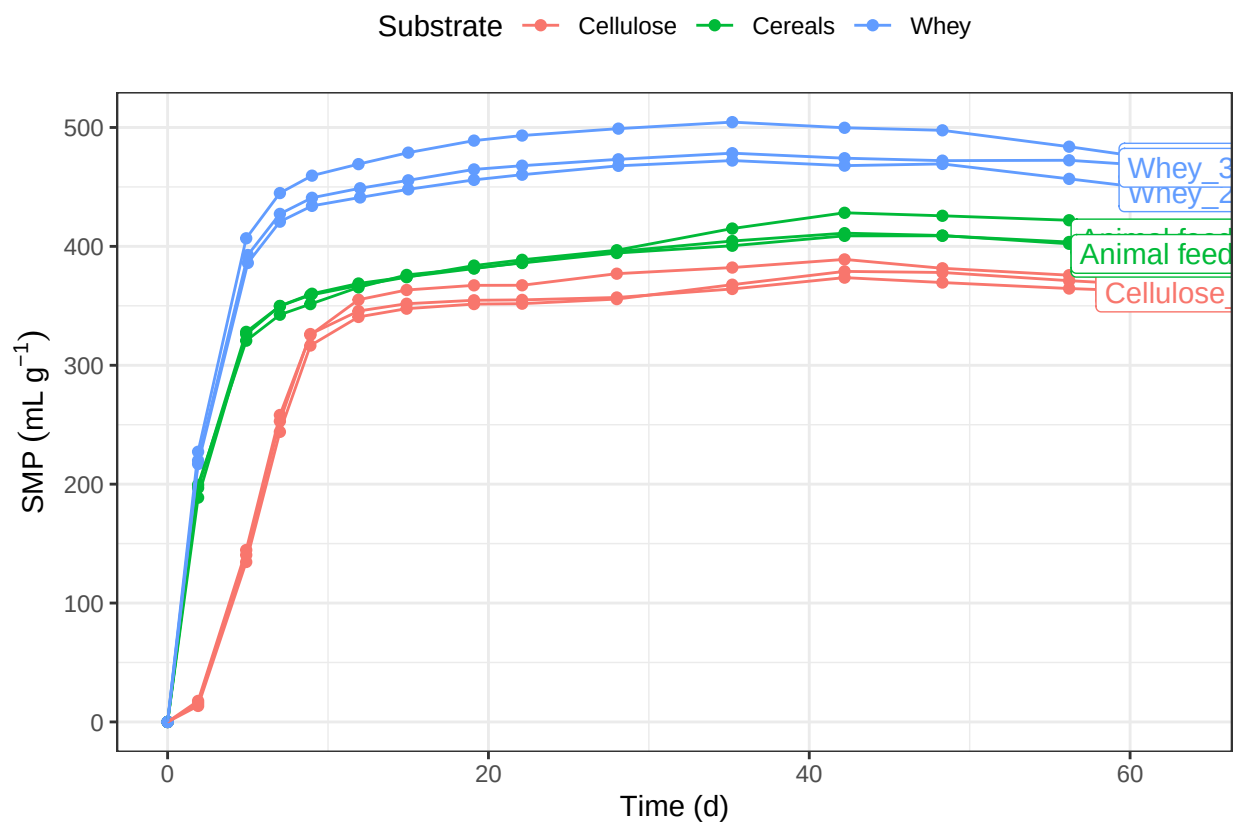
Substrate	Inoculum (g)	Substrate	Inoc. VS (g)	Sub. VS (g)	ISR
Blank	386	0.00	1.82		
Cellulose	390	1.07	1.84	1.06	1.73
Cellulose	373	1.00	1.76	0.991	1.78
Cellulose	392	1.02	1.85	1.01	1.83
Cereals	395	1.09	1.86	0.95	1.96
Cereals	388	1.08	1.83	0.942	1.94
Cereals	391	1.13	1.84	0.985	1.87
Whey	387	1.10	1.83	1.01	1.82
Whey	392	1.10	1.85	1.01	1.84
Whey	388	1.10	1.83	1.01	1.82

7. SMP curves

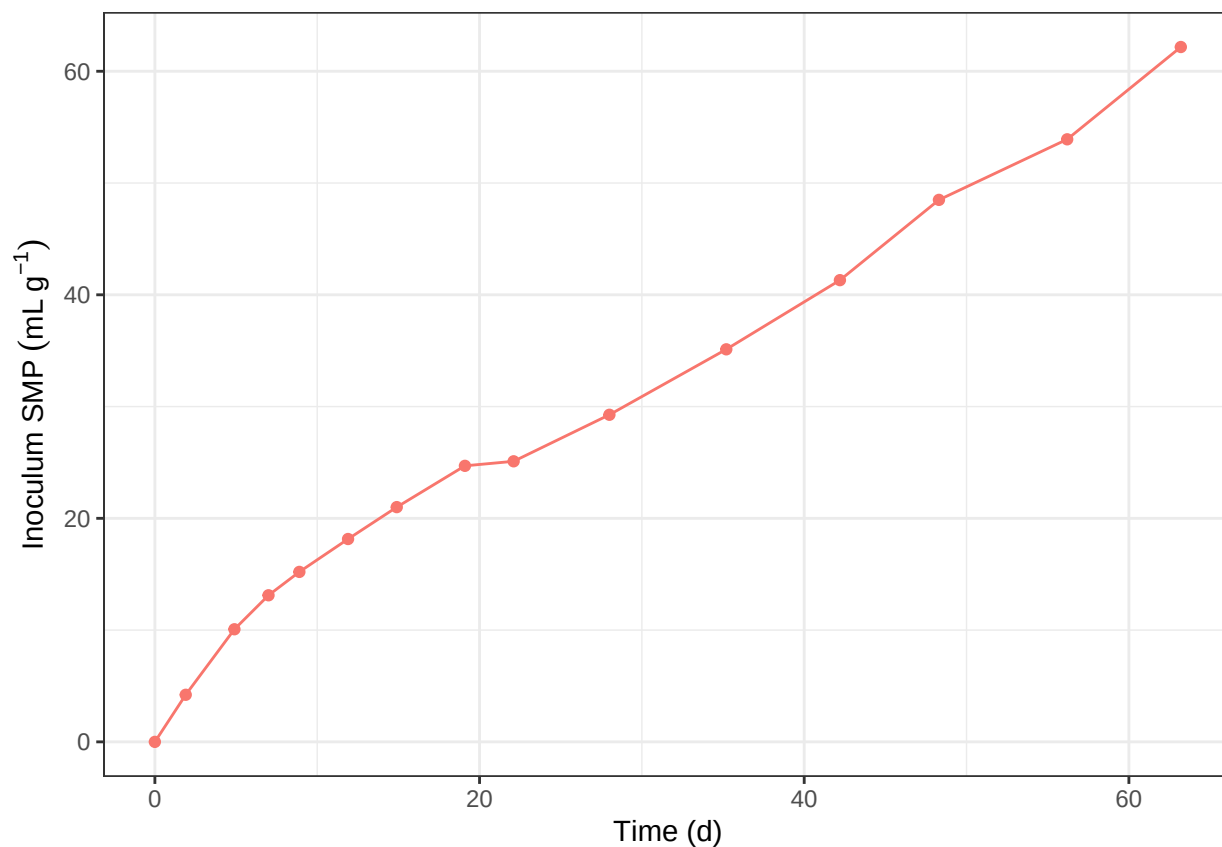
Specific methane production (SMP) curves can help identify the presence of problems in a BMP test, as proposed in this paper:

Koch, K., Hafner, S.D., Weinrich, S., Astals, S., 2019. Identification of critical problems in biochemical methane potential (BMP) tests from methane production curves. *Front. Environ. Sci.* 7, 178. <https://doi.org/10.3389/fenvs.2019.00178>

Here are the SMP curves we calculated from your raw data (using reference lab VS measurements). SMP units are mL of methane (standardized to 0 °C, 1.0 atm pressure, and dry conditions) per g substrate VS. We did not use these for evaluation of your results, but they can be used to show problems in measurements, data entry, ISR, or inoculum activity.



SMP curves for the blanks (normalized by inoculum VS content) are shown below. This plot can be used to check for high variability, insufficient replication (3 bottles are required), sufficient duration (all blanks should be continued to the time of the longest running substrate bottle) or unusually high or low inoculum activity.



For comparison, SMP curves from the five reference labs are shown below for these same substrates. All of these curves are relatively normal. These labs used a variety of methods: AMPTS II or III, manual volumetric, manual manometric, and gas density (GD-BMP).

